

REMARKS

Claims 19-28, 30, 31, 33-37 and 39-41 are pending in this application. Claim 40 has been amended. No new matter has been introduced.

At the outset, Applicant notes that the limitation “organo-metallic-atomic deposited titanium-silicon-nitride layer” is not a product-by-process limitation, as the last Office Action mistakenly asserts, but rather is a *resulting structure* having defined and distinct characteristics.

In R2 Medical Systems, Inc. v. Katecho, Inc., which involved a claim reciting that one element be “affixed” to another, the court found that “‘affixed’ means ‘to be attached physically.’” R2 Medical Systems, Inc. v. Katecho, Inc., 931 F.Supp. 1397, 1425-26 (N.D. Ill. 1996). The Court held that “[T]he terms of the claims do not indicate that ‘affixed’ refers to a process by which the stannous chloride is bound to the conductive plate, but only that it refers to the result of that process.” Id. (quoting CVI/Beta Ventures, Inc. v. Custom Optical Frames, Inc., 893 F. Supp. 508, 519 (D. Md. 1995) (limitation that element be in ‘work-hardened pseudoelastic metallurgic state’ is directed to the structure, not the process, of manufacture)).

In Hazani v. U.S. Int’l Trade Comm’n, which involved patent claims to a memory cell comprising a conductive plate having a surface that was “chemically engraved,” the Federal Circuit also held that the claims were “pure product claims” and not product-by-process claims. Hazani v. U.S. Int’l Trade Comm’n, 126 F.3d 1473, 44 USPQ2d 1358 (Fed. Cir. 1997). The Federal Circuit reasoned that the “chemically engraved” limitation, read in context, described the product more by its structure rather than by the process used to obtain it. Id.

In the present case, amended independent claim 19 recites the limitation “organo-metallic-atomic deposited titanium-silicon-nitride layer” which is a structural limitation and not a product-by-process limitation. An “organo-metallic-atomic deposited titanium-silicon-nitride layer,” like the “chemically engraved” plate of Hazani, is a *resulting*

structure having distinct and defined characteristics. Thus, in view of R2 Medical Systems and Hazani, the limitation “organo-metallic-atomic deposited titanium-silicon-nitride layer” is not a product formed by a particular process.

Claims 19, 21, 22, 24, 25, 28, 30, 40 and 41 stand rejected under 35 U.S.C. §102(e) as being anticipated by Anand (U.S. Patent No. 6,362,528) (“Anand”). This rejection is respectfully traversed.

The claimed invention relates to a dual damascene structure comprising a titanium-silicon-nitride layer. As such, independent claim 19 recites a “dual damascene structure” comprising *inter alia* a metal layer provided within a first insulating layer, “a second insulating layer provided over said metal layer” and “a via situated within said second insulating layer and . . . lined with an organo-metallic-atomic deposited titanium-silicon-nitride layer and filled with a copper material.” Independent claim 19 also recites a trench situated within a third insulating layer and “lined with said organo-metallic-atomic deposited titanium-silicon-nitride layer and filled with said copper material.”

Amended independent claim 40 recites “a damascene structure” which is part of a processor-based system and which comprises *inter alia* “a metal layer provided within a first insulating layer” and “at least another insulating layer provided over said metal layer, said first insulating layer and said at least another insulating layer including a material selected from the group consisting of polyimide, spin-on-polymers, flare, polyarylethers, parylene, polytetrafluoroethylene, benzocyclobutene, SILK, fluorinated silicon oxide, hydrogen silsequioxane and NANOGLASS.” Amended independent claim 40 also recites “at least one opening situated within said at least another insulating layer and . . . lined with an organo-metallic-atomic deposited titanium-silicon-nitride layer and filled with copper.”

Anand relates to a “bonding pad . . . formed in a lattice-like shape.” (Abstract). According to Anand, the bonding pad is “constituted by a conductive member filled in grooves made in an insulating layer having a flat surface.” (Col. 7, lines 26-28). Anand also teaches “an etching stopper layer formed on the insulating layer and having an opening

to expose the bonding pad” and “a passivation layer formed on the etching stopper layer and having an opening to expose the bonding pad.” (Col. 7, lines 28-33).

Anand does not disclose all the limitations of claims 19, 21, 22, 24, 25, 28, 30, 40 and 41. Anand does not teach or disclose a “dual damascene structure” comprising *inter alia* “a via situated within said second insulating layer . . . said via being lined with an *organo-metallic-atomic deposited titanium-silicon-nitride layer* and filled with a copper material,” as independent claim 19 recites (emphasis added). According to Anand, barrier metal 17a, which would arguably correspond to the organo-metallic-atomic deposited titanium-silicon-nitride layer, is formed “on the insulating layer 25, on an inner surface of the contact hole 16a and the inner surfaces of the grooves 16b *by the CVD method or PVD method*” and “is made of, for examples a lamination of titanium and titanium nitride, or silicon titanium nitride.” (Col. 12, lines 7-12; Fig. 31) (emphasis added).

Anand also fails to teach or disclose an “insulating layer including a material selected from the group consisting of polyimide, spin-on-polymers, flare, polyarylethers, parylene, polytetrafluoroethylene, benzocyclobutene, SILK, fluorinated silicon oxide, hydrogen silsesquioxane and NANOGLASS,” as amended independent claim 40 recites. Anand teaches that “an insulating film (borophospho silicate glass (BPSG) or the like) 15 . . . is formed on the transistor” (col. 11, lines 36-39; fig. 27) and that “insulating layer 25 is made of, for example, silicon oxide,” (col. 11, line 44; Fig. 28) and not of the materials recited in amended independent claim 40. For at least these reasons, Anand does not disclose all limitations of claims 19, 21, 22, 24, 25, 28, 30, 40 and 41, and withdrawal of the rejection of these claims is respectfully requested.

Claims 20, 23, 31, 33, 34, 37 and 39 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Anand in view of Venkatraman et al. (U.S. Patent No. 6,093,966) (“Venkatraman”). This rejection is respectfully traversed.

Independent claim 31 recites “a damascene structure” comprising *inter alia* a metal layer “provided within” a first insulating layer, “at least another insulating layer provided over said metal layer, said at least another insulating layer including a material

selected from the group consisting of polyimide, spin-on-polymers, flare, polyarylethers, parylene, polytetrafluoroethylene, benzocyclobutene, SILK, fluorinated silicon oxide, hydrogen silsesquioxane and NANOGLASS.” Independent claim 31 also recites “at least one opening situated within said at least another insulating layer . . . being lined with a titanium-silicon-nitride layer and filled with a copper material.”

Venkatraman relates to “a semiconductor device having a copper barrier layer.” (Col. 1, lines 7-8). Venkatraman recites a copper barrier layer formed when the substrate is “biased by a first stage bias followed by a second stage bias to accelerate the plasma to the substrate . . . where the first stage bias is less than the second stage bias.” According to Venkatraman, the “copper barrier layer 200 is typically a tantalum silicon nitride layer, but may be composed of any combination of refractory metal . . . together with silicon and nitrogen” and “is deposited on the second oxide layer 190 and the insulating layer 180 and along the sidewalls of the opening 195 and 196.” (Col. 5, lines 20-26; Fig. 7).

Claims 20, 23, 31, 33, 34, 37 and 39 would not have been obvious over Anand and Venkatraman. Indeed, the Office Action fails to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Furthermore, the teaching or suggestion to make the claimed combination and the reasonable expectation for success must both be found in the prior art and not based on Applicant’s disclosure. See, e.g., In re Royka, 490 F.2d 981, 180 U.S.P.Q. 580 (CCPA 1974).

In the present case, neither Anand nor Venkatraman, whether considered alone or in combination, teaches or suggests the limitations of claims 20, 23, 31, 33, 34, 37 and 39. As discussed above, Anand fails to teach or suggest “dual damascene structure” comprising *inter alia* “a via situated within said second insulating layer . . . said via being lined with an organo-metallic-atomic deposited titanium-silicon-nitride layer and filled with a copper material,” as independent claim 19 recites. Venkatraman discloses a copper barrier layer that is “typically a tantalum silicon nitride layer, but may also be composed of any combination of refractory metal such as molybdenum, tungsten, titanium, vanadium

together with silicon and nitrogen.” (Col. 5, lines 22-26). Venkatraman, however, fails to teach or suggest “an organo-metallic-atomic deposited titanium-silicon-nitride layer,” as independent claim 19 recites.

Claims 33, 34, 37 and 39 depend from claim 31. As discussed above, Anand teaches that the “insulating layer 25 is made of, for example, silicon oxide.” (Col. 11, line 44; Fig. 28). In addition, Anand does not teach or suggest an “insulating layer including a material selected from the group consisting of polyimide, spin-on-polymers, flare, polyarylethers, parylene, polytetrafluoroethylene, benzocyclobutene, SILK, fluorinated silicon oxide, hydrogen silsesquioxane and NANOGLOSS,” as independent claim 31 recites. Venkatraman also fails to teach or suggest the limitations of independent claim 31. Venkatraman teaches an insulating layer including “organic thermoplastic and thermosetting polymers such as polyimides, polyarylethers, benzocyclobutenes, polyphenylquinoxalines, polyquinolines . . . and polymers of polysiloxane” (Col. 4, lines 42-53).

Since neither Anand nor Venkatraman teaches or suggests the limitations of independent claims 19 and 31, the subject matter of claims 20, 23, 31, 33, 34, 37 and 39 would not have been obvious over Anand in view of Venkatraman, and withdrawal of the rejection of these claims is respectfully requested.

Claim 27 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Anand and further in view of *Ti-Si-N Diffusion Barriers Between Silicon and Copper* by J.S. Reid et al. (“Reid”). This rejection is respectfully traversed.

Claim 27 depends from amended independent claim 19. As discussed above, Anand fails to teach or suggest a “via being lined with an *organo-metallic-atomic deposited titanium-silicon-nitride layer* and filled with a copper material,” as independent claim 19 recites (emphasis added). Reid teaches that “ $\text{Ti}_{34}\text{Si}_{23}\text{N}_{43}$ thin films are exceptional diffusion barriers between silicon and copper” and that “100 nm and 10 nm films are able to prevent copper from reaching the silicon” (page 299, second column, last paragraph), but Ti-Si-N thin film “depositions were made by rf-sputtering in a chamber.” (Page 298, first column,

second paragraph). As discussed above, it is known that deposition by ALD provides improved step coverage over deposition by sputtering, which is particularly important for the Ti-Si-N diffusion barrier deposited on the sidewalls of vias and trenches. Therefore, the product of “organo-metallic-atomic deposited titanium-silicon-nitride layer” is not taught or suggested by Anand or Reid. Since Anand and Reid do not teach or suggest all the limitations of independent claim 19, the subject matter of claim 27 would not have been obvious over Anand in view of Reid, and withdrawal of the rejection of this claim is respectfully requested.

Claims 35 and 36 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Anand in view of Venkatraman and Reid. This rejection is respectfully traversed.

Claims 35 and 36 depend from independent claim 31. For at least the same reasoning set forth above regarding the patentability of claim 31 as not obvious over Anand and Venkatraman or Anand and Reid, the Anand, Venkatraman and Anand references combined would not have rendered its subject matter obvious. None of Anand, Venkatraman and Reid teach an insulating layer including a material selected from the group recited by the claimed invention. Since Anand, Venkatraman and Reid do not teach or suggest all the limitations of independent claim 31, the subject matter of claims 35 and 36 would not have been obvious over Anand in view of Venkatraman and Reid and withdrawal of the rejection of these claims is requested.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is

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respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

By 

Thomas J. D'Amico

Registration No.: 28,371

Gabriela I. Coman

Registration No.: 50,515

DICKSTEIN SHAPIRO MORIN &

OSHINSKY LLP

2101 L Street NW

Washington, DC 20037-1526

(202) 785-9700

Attorneys for Applicant